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ON  
THE PROPERTIES OF MATTER,  
THE  
PRINCIPLES OF CHEMISTRY,  
AND  
THE NATURE AND CONSTRUCTION  
OF  
AERIFORM FLUIDS,  
OR  
GASES.

IN WHICH THE ABSURDITIES OF THE THEORIES HITHERTO ADVANCED, AND GENERALLY RECEIVED, RESPECTING THOSE SUBJECTS, ARE FULLY EXPOSED; AND SUCH AN EXPLANATION OF THEM GIVEN, AS REASON, NATURALLY, POINTS OUT; AND EVERY OBSERVATION, FULLY, CONFIRMS.

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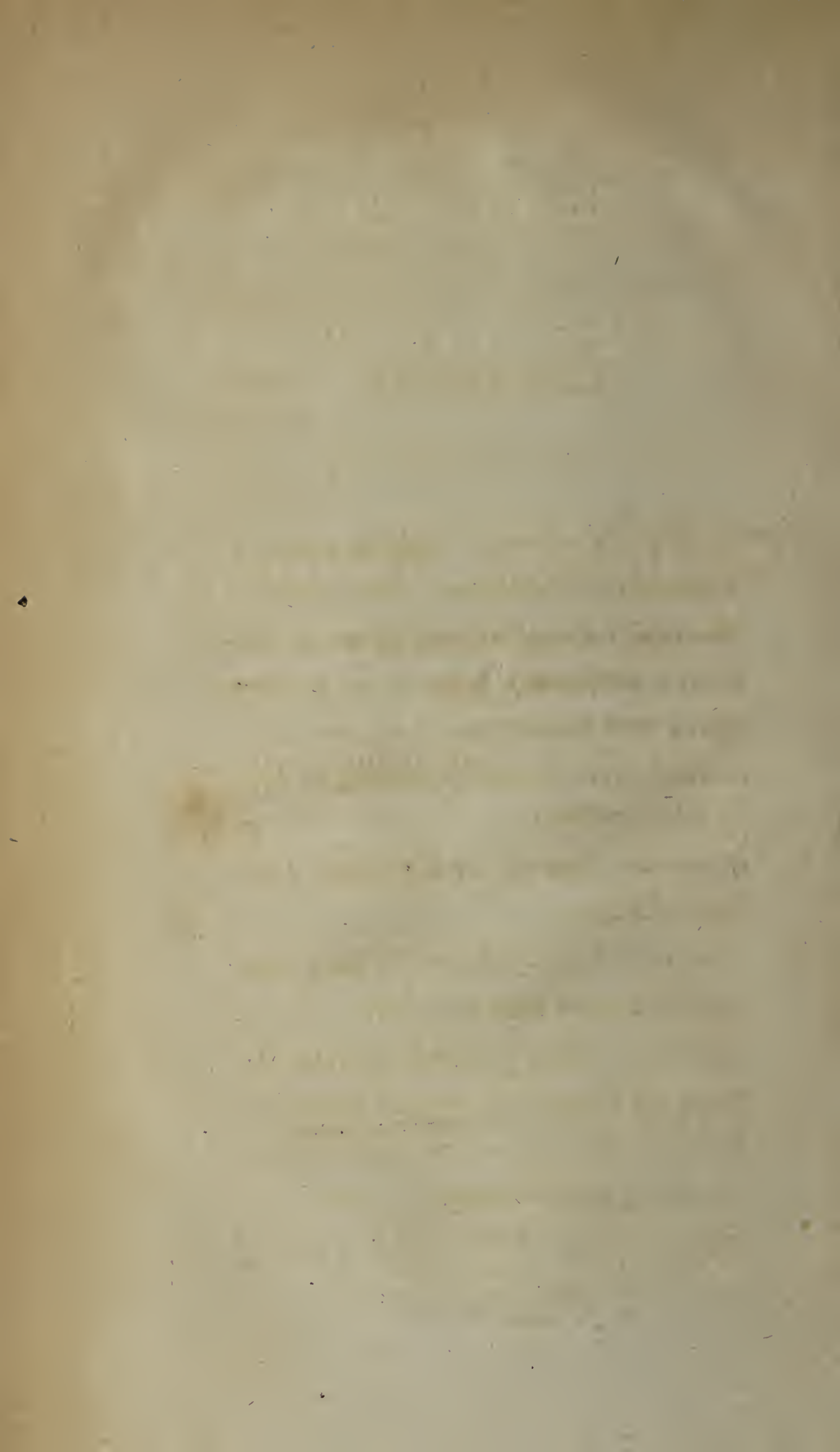
BY  
E. PEART, M.D.

AND CORRESPONDING MEMBER OF THE MEDICAL SOCIETY  
OF LONDON.

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## SECTION I.

*On the erroneous opinions and false reasonings of philosophers, with respect to matter, its properties, and modes of existence ; particularly when in an aeriform state ; with an attempt, at the same time, to rectify them, by strictly adhering to reason and experience.*

THE metaphysical speculations of philosophy, may lead us to doubt of the existence of matter, but not without destroying the testimonies of our senses, and involving us in all the inconceivable mysteries of immaterial powers, possessing the very properties, which plain sense teaches us to attribute to matter.

If our ideas of solidity and resistance arise from immaterial, repulsive spheres, surrounding parti-

cles of matter, what occasion have we to suppose that there is any such thing as matter?—take away the particles of matter, leave but the repulsive spheres, and our sensations and ideas of solidity and resistance, will be just the same.

If those ideas are produced by immaterial repulsive spheres, what proof have we—what right have we to say, that they have centres of solid matter? Would it not be the most concise and philosophical, at once, openly, to assert, that, as our ideas of solidity and resistance arise from repulsive powers, we have no proof that matter is contained within those spheres, and, therefore, there is not one particle of matter in the universe?

This immaterial sphere of repulsive power acting upon other immaterial spheres of repulsive power, metaphysically considered, gives indeed the ideas of solidity and resistance; and so does one solid particle of matter acting against another: and, as the idea of solid matter, appears to

be rather more intelligible and comprehensible than immateriality, I shall think myself justified by reason, in preferring the substance to the shadow.

If it be said that the sphere of repulsion, is a property, which depends upon the particle of matter as its centre, therefore, matter is necessary: may I not say that if matter be necessary, spheres of repulsion are not: for it may be conceived that two solid bodies cannot, at the same time, be in the same place, and consequently every attempt to force them, nearer than contact, must be in vain, and must give an idea of resistance: but, the idea of particles of matter, not in contact, resisting each other, by immaterial, repulsive spheres, extended around them, is beyond our comprehension, without proof, and, very fortunately, not necessary. Admitting therefore, the existence of matter, the only idea that reason or observation authorizes us to form of repulsion, is the resistance, that two or more particles of matter, make against each other,



when any attempt is made to bring them nearer than contact.

Were we to pursue the doctrine of immaterial active spheres still further, our dissatisfaction, or our fondness for incomprehensible mysteries must still increase, when we are told, that within this repulsive sphere, is another, equally immaterial, wonderful, and incomprehensible, of an opposite kind ;—a sphere of attraction.—If two particles are forced together, by a power overcoming their repulsive spheres, their attractive spheres then come into action, and forcibly hold those particles together.

But, admitting these spheres, there seems to be a strange irregularity in their extent and disposition ; a certain particle will attract one thing, and not another ; some spheres of attraction require contact, and produce cohesion ; others act at a great distance, as in magnetism, and electricity ; in some cases these attractive spheres *may* be supposed to be surrounded by those of re-



pulsion, where force is necessary to produce the attraction of cohesion ; in other cases, such a supposition is absolutely inadmissible, as when a magnet attracts iron, without the least appearance of first repelling it : in fact, the idea of particles of matter, being surrounded by immaterial spheres of attraction, and beyond those of repulsion, is inconsistent, insufficient and incomprehensible ; it cannot assist us in accounting for the appearances and operations of nature, but, if strictly adhered to, will involve us in darkness and confusion : and the supposition of an alternation of repulsive and attractive spheres, surrounding the same particle, only increases that confusion.

But there is an *attraction*, as is abundantly evident to every observer of nature ; and all that we can say of it, is, that it is a *property* : a property, by which, the particles of matter are *actuated* ; a property, by which one particle of matter is *forcibly detained* by another ; but, as being a property belonging to matter, it cannot act *beyond* its particle : it cannot act where that par-

ticle is *not* : two particles can only *attract* each other, when in *contact*.

But, because we cannot comprehend the nature of this property, of this attraction, are we to have recourse to immateriality?—is not that solving *obscurum per obscurius*?—when we say one particle of matter hath the property of attracting another particle of matter, is not that more simple and intelligible, than to say that a particle of matter is surrounded by an immaterial sphere, which immaterial sphere hath the property of attracting another immaterial attractive sphere, surrounding another particle of matter?—for granting, for a moment, the existence of immateriality, it does not follow that attraction is essential to that immateriality, or implied in its existence, for if it were, what would become of the equally immaterial sphere of repulsion, attributed to matter?—therefore, if there can be an immaterial existence, it may still be without the power of attraction, and, consequently, if matter be supposed to be surrounded by an immaterial sphere, we must

likewise add, that that immaterial sphere hath the property of attraction given to it ; and, therefore, it is more simple and rational to say, that *matter* hath the *property* of *attracting* matter, without any immaterial sphere being employed, or necessary.

One great reason, therefore, why philosophers are yet without principles, is, they assume the power of creating properties out of nothing, and use them as realities. Ask for a clear explanation of their imaginary powers, and they cannot give it.—Bring them to the test of common sense and they vanish—or, endeavour to form an Idea of them, and the mind will be found unequal to the task.

For when 'tis said that when two particles of matter, or two bodies, at a certain distance from each other, refuse to approach nearer, than that distance, that they repel each other, and when two bodies at a certain distance, rush together, that they attract each other ; and that that repul-



sion, or attraction, is effected by an immaterial property, or sphere of repulsion, or attraction, surrounding each particle, and consequently, that matter can act where it is not, by an immaterial power, the assertion is unphilosophical, inconceivable, and unnecessary : and is evidently contradicted in some cases, and consequently is unnecessary and unwarrantable in all.

For instance, a magnet will attract iron to a determinate distance :—heat the magnet to a certain degree, and it will not attract iron, at any distance. Had it attracted the iron, at first, by means of an immaterial sphere of attraction, that immaterial sphere could not have been affected by fire : but it is destructible by fire : consequently, the power, by which the magnet attracts iron, is material ; and we have means of communicating, or destroying it, at pleasure.

But, if this magnetic power be material, the magnet itself is also material : why therefore cannot we see, feel, and be sensible of the pre-



fence of this magnetic matter, as well as of the magnet itself?

We can see and feel ice, but are not sensible of its presence when thrown into the state of vapour, though by the change of state, its particles have not lost their materiality. In the former case, when in the state of ice, the particles were closely and firmly attracted together, in every direction, so as to form a solid body, capable of making considerable resistance to other bodies, pressed against it, and consequently, of making impressions upon the senses, capable of being perceived; but, in the state of vapour, those particles are so distant, and so little attractive to each other, that they have no combined force of action upon our senses, and are, singly, too small to make any impression, capable of being perceived.

The magnet, therefore, may be seen and felt, as being formed of a great number of solid particles, crowded, or forced together, in every direction, so as to form a solid, capable of making sensible impressions upon the organs of sense;

while the particles of magnetic matter, may be simply connected by contact, in one direction only, so as to form lines of magnetic particles, extending from the magnet, as a centre ; these lines not being in contact with each other, have no power of making resistance, or impressions upon the organs of sense, more than what resides in each single particle, or line of particles ; which simple force, is too small to be sensible to us.

A magnet, therefore, is an aggregation of particles of matter, so numerous and closely connected, in every direction, as to form a solid body, evident to the senses : it attracts iron, at a certain distance from itself, by means of a number of particles of matter, simply in contact, so as to form lines of particles, which lines are unconnected with each other, but extended from the magnet as the centre, to the circumference, or to a certain distance, so as to form an atmosphere around it : this magnetic atmosphere of solid particles, we know exists, because we can communicate, or destroy it ; and, therefore, by the activity of this material, magnetic atmosphere,

we know that the repulsions and attractions, called magnetic, are effected.

Consequently, in this case, we know that the two distant bodies, do not *attract* each other by any immaterial spheres, but by a medium of *particles* of *matter*, in an *atmospheric* state ; therefore, we are under no necessity of supposing, that any two distant particles attract, or repel each other, by immaterial powers ; but, reasoning from analogy, and avoiding the multiplication of causes to produce effects, we must, and can rationally, only conclude, that *every* appearance of attraction, or of repulsion, taking place between distant bodies, is effected by a similar intermedium of *material particles*, in the state of an *invisible atmosphere* around *one* or *both* of the bodies, which, though distant, produce effects upon each other.

This conclusion is that of common sense ; we see particles attract others at a distance, and conceive, readily, that the attraction is effected, by means of the particles arranged around the attracting body, and extending to the body attracted,



may we know that such is in reality the case, in magnetical and electrical experiments, and is as easily and naturally conceived in every other case of attraction ; but, that matter should act where it is not,—that a body should attract another, distant from itself, without any material intermedium, but by an immaterial sphere of attractive power, is so inconceivable, and unnecessary, that, after justly considering the subject, no man, who is capable of reasoning, and dare think for himself, can hesitate, to give up an opinion founded on conjecture and incomprehensibility, for an explanation founded on fact, and readily presenting itself to the mind.

The advocates for immaterial powers, and repulsive spheres, will be ready to object to me, it is a presumptive proof that resistance is owing to repulsive powers, acting at a distance from bodies, that if a number of flat pieces of metal be placed upon each other, and an electric shock be transmitted through, or along them, the electric fluid will be visible, as it passes from one piece to the other ; which proves that they are not in con-



tact ; for if they were, it would not be visible.  
 This experiment indeed proves that the metal plates are not in contact ; but it does not prove that there is no intermedium of what I call actuated, or atmospheric particles, upon which that seeming repulsion may depend : on the contrary, I maintain, that that very repulsion is effected, merely by the atmospheres of actuated matter, naturally surrounding every particle of matter of the other kind, and, consequently, every body, formed of what I call fixed particles of matter ; the extent of these atmospheres being various, depending upon certain circumstances, which, at present, need not be considered : and it is most rational to conclude, that, if the north poles of two magnetic needles, are prevented from coming into actual contact, by means of the magnetic atmosphere surrounding each, resisting the other, so my hand is prevented from actually touching the paper upon which I write, by means of the atmosphere of active particles, surrounding the fixed particles of which my hand is composed, pressing upon the atmosphere surrounding the particles composing the

surface of the table ; which actuated atmospheres, in fact, are the efficient causes which unite the fixed particles of matter, of which the table, or, my hand is formed, into a solid, compact body.

It is evident therefore, that there is no necessity to suppose the existence of immaterial spheres of attraction, or repulsion ; and, as we can form no idea of immateriality, we have no right to assume it in reasoning, especially, as we can do better without it : for reasoning upon inconceivable principles, is reasoning upon we do not know what ; and must, therefore, inevitably lead us into all the absurdities of mysticism, and wild conjecture.

There is another great source of error and confusion in philosophy, arising from pretending to explain certain effects, by means of certain terms, of which we have certain ideas ; but without our being capable of forming any idea, of the mode in which they must exist, so as to be able to produce the effects in question.—In fact, 'tis too common with philosophers to make

use of a jargon of words, without any settled ideas belonging to them. For instance, some philosophers say, that pure air is formed of oxygen with caloric or fire : others that it is a farra-go of I don't know what, with an atmosphere of concentrated fire ; and that other kinds of airs, or gases, are formed of certain kinds of matter, with atmospheres of fire or caloric.

Now, what idea can we form of the state of this fire, when it surrounds a particle of matter, so as to render it aeriform ?—If I heat a ball of metal, or some grains of sand, I know they become surrounded by atmospheres of fire, because they feel hot to the fingers, and expand the mercury in the thermometer. The nitrous acid may be made sensibly hot to the touch, and not alter its state ; and yet, without any evident heat, it may change to the state of pure air, without feeling hot ; nay, even though it feels cold : and the reason given for its aeriform state, is, that its particles are kept asunder, by the interposition of fire !—but have we a right to make such an assertion ?



Can we form any idea of the manner in which fire can form a permanent atmosphere, around a solid particle of matter, of considerable extent, without having its constant effect of producing heat, or of exciting that sensation, which at all times accompanies it, when we know it exists, in a quantity, much less, than it is said to be in, when forming the atmospheres of aeriform fluids, or rendering solid particles aeriform?—and by adding the term concentrated to it, is not the difficulty still increased?

Fire when surrounding any body, in a certain quantity, gives the sensation of heat; for instance, a stone heated.

The atmospheres surrounding particles of matter, and rendering them aeriform, for instance, pure, cold, frosty air, gives no sensation of heat, but the contrary.

Particles of acid may have fire enough surrounding them to appear hot, without being aeriform.



Particles of the acid principle may have elastic atmospheres, rendering them aeriform, without being sensibly hot. The elastic atmospheres of gases are permanent, and not destructible by cold; but fire, itself, in no one case that we know of, ever forms a permanent atmosphere, but readily passes from the body heated, to any colder body near it. Therefore, fire, and the atmospheres rendering bodies aeriform, have no properties alike; they are, consequently, different things; for, it is unwarrantable, it is contrary to reason, to experience and to sound philosophy, to assert, that two things, having no properties alike, can be the same thing.

If a particle of matter, then, is not rendered aeriform by means of fire, what, more rational, or conceivable idea, are we to form?

Air is compressible and elastic, therefore not a solid whose particles touch in every direction.

It is possessed of weight and the power of resist-

tance, therefore it is composed of solid matter ; consequently,

Air is composed of particles of matter, arranged in a certain manner, so as not to be in contact in all directions. But,

There is no proof of matter acting, per se, where it is not ; neither is it possible to conceive, how it can act, at a distance from itself : therefore, air is composed of solid particles of matter, arranged, singly in contact, in a rectilinear manner, around other particles, as centres, so as to form elastic atmospheres.

I have shewn, that a magnet is surrounded by an atmosphere of magnetic particles, invisible on account of their linear arrangement ; that magnetic atmosphere hath no properties in common with fire, and, very justly, was never supposed to be fire : is it not easy, is it not natural, then, to suppose, that other particles of matter, as well as iron may have atmospheres of some kind or other, similar in their mode of atmospheric arrangement,



with those forming the magnetic atmosphere?—may not a single particle have its complete atmosphere of this something, which is not fire?—and may not its elasticity, levity, and invisibility, depend upon those atmospheric particles? Certainly, if the north poles of two needles, have each an atmosphere of something, different from fire, which prevents their approaching each other, nearer than contact, 'tis allowable, 'tis natural to suppose that two simple particles of matter, may each have an atmosphere, of something different from fire; which, will prevent their coalescence; and, if forced, nearer, than where those atmospheres come in contact, so soon as that force is taken away, the atmospheres will recover their due arrangement, and recede to their proper distance, giving the ideas of repulsion, and elasticity, in the same manner as the two north poles of two magnetic needles do.

The assertion, therefore, that gases owe their elastic, expanded state to the presence of fire, forming atmospheres around their bases, is unphilosophical, unnatural, and unnecessary; and

all that appearances allow us to conclude, in this case, is, that the *solid bases* of air, are surrounded by *atmospheres* of particles, in a *rectilinear* arrangement, which keep them asunder; and, that those atmospheres, having no properties resembling fire, are *not fire*, but *something else*, capable of taking that atmospheric state of arrangement, around those particles of matter, of which the basis of air is formed.

There is still another fundamental error, the corner stone of modern philosophy, from whence, in a great measure, arises those inconsistencies, and uncertainties, so repugnant to common sense, and so obstructive to the progress of true knowledge; which, can never be hoped for, till we have true principles, upon which to establish it. The false reasoning I allude to, is, attributing different and irreconcilable effects to the same cause, in similar circumstances.

As an example, I bring the present, universally adopted theory, that *all gases* owe their aeriform state to the fire surrounding, or some how, or



other, connected with the bases of the different gases.

Modern theory says, that vitriolic acid air is formed of the acid particles and caloric ; that is, the particles of acid are surrounded by fire, which forms itself into elastic atmospheres around them ; in consequence of which, any two particles of acid cannot come into contact, on account of the atmosphere of fire, surrounding each ; therefore, two atmospheres of fire repel, or refuse to come nearer than the point of contact with each other.

In the same manner it explains the production of alkaline air from volatile alkali ; the alkaline particles become surrounded by atmospheres of fire, which atmospheres, resisting each other, prevent the particles of alkali from coming into contact ; and, consequently, keep them asunder, in the state of an elastic fluid.

Atmospheres of fire, then, when they surround particles of acid, or of alkali, according to the modern doctrine of aeriform fluids, have no at-

traction to each other; and prevent the acid, or alkaline particles they surround, from touching, or acting upon each other, when similar.

But, if we mix a quantity of acid air with alkaline air, the two atmospheres rapidly unite; the acid and alkaline particles are drawn into contact, and, by combination, form a neutral salt, which is precipitated; and the bulk of the two airs, depending upon their elastic atmospheres, disappears.

This experiment, therefore, contradicts the former conclusion; for, if the atmosphere of fire surrounding one particle, be repulsive to a similar atmosphere investing another, and keeps them asunder in one case, it ought to do so in all; for as the atmospheres, by their resistance to each other, prevent their respective central particles from coming into contact, it cannot affect that repulsive property, whether the central particles be both acid, both alkaline, or one acid and the other alkaline: but, this experiment fully declares, that the atmosphere surrounding a particle



of acid, attracts and combines with an atmosphere surrounding an alkaline particle ; and they disappear together. Consequently, it proves, that the doctrine of fire being the cause of the elasticity of all gases, is false ; because it makes two similar atmospheres of fire, to be repulsive in some cases, and attractive in others, which is attributing contrary effects to the same cause, in similar Circumstances ; which is unphilosophical, inadmissible, and repugnant to reason ; and would not have been thought of, but to support a lame theory.

And where is the necessity for having recourse to such inconsistency ?—A magnet gives us the idea of matter and solidity, its magnetic atmosphere shews us that there are particles of matter, *different from fire*, which are capable of surrounding solid bodies, in an *atmospheric* form ; and, as before observed, we are supported by reason and analogy, when we suppose that a particle of air, is a particle of matter, with an atmosphere of some such kind as that, surrounding the magnet—an *elastic atmosphere*, *different* in its nature and properties from *fire*. And will not the ana-



logy help us still further?—will it not assist the mind to comprehend and explain the difficulties in question?—The north pole of every magnet attracts iron, it hath therefore an atmosphere of magnetic matter : so, for the same reason, hath the south pole of every magnet.

Particles of vitriolic acid, when rendered aeriform, are much more distant than when in their acid state, therefore, they must have atmospheres, of some kind, surrounding them, which prevents their coalescence : for the same reason, particles of volatile alkali, when they become aeriform, must have elastic atmospheres of some kind, or other, around them.

The north poles of two magnets will not come into contact, on account of the resistance made by the atmospheres surrounding them, pressing against each other : neither will two south poles, for the same cause.

Two particles of vitriolic acid in the state of air, cannot come into contact, by reason of the

elastic atmosphere surrounding each particle ; neither will two particles of alkali, in an aeriform state, naturally, approach each other, nearer, than where their respective atmospheres begin to touch each other.

The north pole of one magnet will strongly attract, and be rapidly drawn into contact, by the south pole of another, so soon as their respective atmospheres of magnetic fluid come into contact, in which state they will remain forcibly held together ; which fully proves, that the magnetic atmosphere surrounding the north pole of *one* magnet, is *powerfully attractive* to the atmosphere surrounding the south pole of *another*.

Particles of alkaline air will rapidly combine with particles of vitriolic acid air, by which means, the acid and alkaline centres are drawn into contact, combine, and form a neutral salt ; which proves, that the *atmosphere* surrounding a particle of *acid*, so as to render it aeriform, is *attractive* to the *atmosphere* enveloping a particle of *alkali*.

It is evident then, that the aeriform state of bodies, strongly resembles the magnetic state of iron ; but, the magnetic fluid was *never* supposed to be *fire*, but an *active fluid*, of some kind, very *different* from it : consequently, we have *no reason* to say, that the aeriform state of bodies depends upon fire ; since the atmospheres, surrounding bodies, upon which their aeriform state depends, are *so different*, in their mode of existence and properties, from *fire* ; and, the analogy of magnetic fluids, so strongly authorizes our supposing and asserting, that active particles, capable of forming elastic atmospheres around bodies, *do exist*, which are very different from fire.

Since, then, we are not under the necessity of supposing, that every elastic atmosphere is fire ; since we know that there are particles of matter, distinct from fire, which have the property of arranging themselves around certain particles, or bodies of matter, in an atmospheric state, we are perfectly at liberty to suppose, that if there is *one* kind of *active particles* of matter, which have that property, there may be *two* ; and the supposition



is not only admissibile, but probable ; nay, even demonstrable.

The north poles of two magnets will attract iron, at a certain distance ; so will the south poles of two magnets : therefore, each is certainly surrounded by an atmosphere of magnetic particles, of a certain extent.

The north pole of one magnet repels the north pole of another ; therefore, two *similar* magnetic atmospheres, will not combine, but *resist* or *repel* each other.

The *north* pole of *one* magnet, will *attract* the *south* pole of *another* ; therefore, the atmosphere surrounding the north pole, is *different* from that around the south pole : otherwise it would repel it, in the same manner as it did the north pole : but it does not repel it ; therefore, as contrary effects cannot arise from the same cause, *cæteris paribus*, the atmosphere surrounding the north pole of a magnet, is an active fluid, *different* from

and attractive to the atmosphere around the south pole ; and both are very different from fire.

Reason, then, shews us, that there must be, and are *two active fluids*, capable of forming *atmospheres* around certain bodies, as is abundantly evident in magnetic experiments ; and to pursue the analogy, our reason will point out to us, that those two active fluids, are the causes of the aeri-form states of bodies : for, *without two* such active fluids, we cannot explain those states ; and *with* them their natures are readily conceived, and naturally explained, without a difficulty.

Particles of acid air repel each other, to a certain distance ; because those acid particles are, each, surrounded by an atmosphere of one and the *same kind* of active fluid.

Particles of alkaline air repel each other ; because, each hath a *similar* atmosphere of active fluid.

And, as the north pole of one magnet is attract-

ed by the south pole of another, so a particle of acid air is attracted into combination, by a particle of alkaline air, so soon as their respective atmospheres touch each other ; therefore one is of *one kind* of active fluid, and the other of the *contrary* kind, and strongly attractive to it.

It may be asked, why ought we to suppose that the *same two* active fluids which produce the phenomena of magnetism, form also the atmospheres of aeriform fluids ?

I would answer, because we have no right, or reason to admit of more causes than are necessary to explain effects ; and because the *resemblance* between *atmospheres* of every kind, is *so great*, as to lead us, naturally, to suppose, that *all* are formed of the *same principles*.

The north pole of a magnet, the south pole of a magnet ; a body electrified by means of glass, a body electrified from resin ; a particle of acid air, and a particle of alkaline air have *each* an invisible, atmospheric arrangement of active parti-



cles, around their respective solid centres ; because they can act upon certain bodies, distant from themselves : the north poles of two magnets, the south poles of two magnets ; two bodies electrified from glass, two bodies electrified by resin ; two particles of acid air, and two particles of alkaline air resist, or repel each other, and will not approach, nearer than where the two atmospheres come in contact ; if they are made to approach nearer, by force, so soon as that force is taken away, the active particles, by the force with which they recover their due, rectilinear arrangement, again push each other to their former distance ; and hence their elasticity.

So far, *all atmospheres*, whether magnetic, elastic or aeriform, strongly *resemble* each other, and seem to be the *same active fluid*, only in *different* circumstances and states of excitement.

The north pole of one magnet, powerfully attracts the south pole of another ; the electric atmosphere communicated to a body by means of glass, strongly attracts an electric atmosphere

acquired, by another body, from resin ; and the atmosphere rendering a particle of acid aeriform, forcibly attracts the atmosphere around a particle of alkali, when in the state of air.

Can there be a doubt, then, that the active fluid, giving magnetic properties to the north pole of a magnet, is of a *different* kind from that surrounding the south pole ?—and is it not equally evident that the electric fluid excited by means of glass, is specifically different from, and attractive to that formed by resin ; and, for the same reasons, is not the aeriform state of an acid particle, caused by a *different* atmospheric fluid, from that which surrounds a particle of alkali in an aeriform state, and which it powerfully attracts ?—In magnetism, in electricity, and in aeriform fluids are there not, evidently, *two fluids*, forming those atmospheres, *similar* in their modes of arrangement, and in their being attractive to each other ?—and have we not reason, then, to conclude, that the *same two active* principles, produce *all atmospheres*, whether magnetic, electric, or aeriform ? the peculiar properties, wherein they

differ, being produced by the *different states* of the bodies giving them excitement, and the *different degrees* of excitement they acquire. As a further argument for their being the same principles, in three different states, will not the electric fluid give magnetic atmospheres to iron? and will not electricity render certain bodies aeriform, by giving them the atmospheres, upon which their aeriform states depend? in short, the only objection to their being the same kinds of active fluids, is, that magnetic, electric and aeriform atmospheres have no sensible effect upon each other; which objection, merely resolves itself into this, that, of two fluids, naturally attracting each other, one, or both may be so circumstanced, that that natural attraction *cannot* become *evident*; which, in reality, is no objection at all; as experience daily proves: to give one instance—vitriolic acid may be converted into air, in which state, its particles are surrounded by atmospheres of one of the active fluids, as is evident from their distance and repulsion to each other.

Volatile alkali may become aeriform, by its



particles being furrounded by atmospheres of one of the active fluids ; the fluid furrounding each alkaline particle being of the same kind.

If these two gases be mixed together, the atmospheres will mutually attract each other, and drawing their respective centres of acid and alkali together, will leave them united in the form of a neutral salt ; consequently, the atmospheres furrounding the acid particles, were of *one* kind, and those around the alkaline particles, of the *other* kind of *active fluid*.

In this experiment, *one* kind of fluid is *attractive* to the other. But, electrify the alkaline air, and its bulk will be increased, by the acquisition of more of the atmospheric fluid, which, extending the atmosphere around each alkaline particle, pushes them still further asunder ; in this state, by an increase of atmosphere, it acquires new properties, or rather, a different degree of activity. If it be now mixed with vitriolic acid air, they will be found to have *no action* upon each other, though the atmospheric fluid furrounding

the alkaline particles, is of the *same* kind as before ; and, is, consequently, of the *contrary* kind to that surrounding the acid particles, which before attracted it, when less expanded in the state of alkaline air : which proves, that the *two* fluids, though naturally attractive to each other, may be so circumstanced, as to have *no sensible action* one upon the other ; and, that leads us to conclude, that the *two active* fluids, in *similar* states of *excitement*, are capable of acting upon each other ; but, in *very different states* or *degrees* of *excitement*, that action is *not evident*.

But this subject, in this place, I shall say no more of ; having particularly examined it in my Elementary Principles of Nature, where, having explained my principles, I was more at liberty to fully consider it.

Having thus pointed out some of the errors, of philosophy, and the causes of many other philosophical inconsistencies ; having proved that there is no necessity for supposing immaterial powers, and in fact, that the supposition is ridiculous in

itself, without one idea of their nature, or one proof of their existence ; having proved that matter, alone, is sufficient to explain the very phenomena, in which immaterial powers were thought necessary,—matter, with such properties as we know, to a certainty, it may, and does possess ;—having, in short, pointed out the true principles of nature, which reason teaches when the prejudices from the false chimeras of philosophy are removed, it would be a laborious and unpleasant task, to examine all the fashionable follies of philosophy ; there, however, are a few glaring inconsistencies, in one modern theory, which I must mention, and those so gross as to make me wonder, how any sensible man could advance a theory so full of them ; or how any others, who possess any degree of discernment, should so readily overlook those inconsistencies, for the sake of adopting the theory. I have so great an opinion of Mr. Lavoisier's good sense, as to firmly believe that he knows, and feels with dread, the defects of his own theory, arising from its inconsistency ; an inconsistency, which his theory cannot be made to obviate, and which therefore, proves its im-



perfection and fallacy. But since others have been blind enough, or kind enough to overlook it, he hath never troubled the world with his own apprehensions.

Mr. Lavoisier says that mercury is a simple substance ; that pure air, or oxygen gas is composed of oxygen and caloric or the matter of heat, or fire : he allows that, by means of heat, mercury will attract the oxygen from caloric ; and he allows, likewise, that by means of heat, caloric will attract oxygen from its combination with mercury ; which is attributing contrary effects to the same cause, without assigning any cause for those different effects ; or without having it in his power to assign any, consistent with his theory ; which is, therefore, inconsistent with itself, and consequently imperfect : for, were mercury a simple substance, and oxygen gas composed of oxygen and caloric, it is impossible that such different results could arise, by their being exposed to any quantity of caloric whatever.

He likewise says that azotic gas is formed of azote rendered aeriform by caloric ; and that oxygen gas is formed of oxygen and caloric : when these are mixed together and exposed to the action of the electric spark or fluid, the oxygen combines with the azote, and forms nitrous acid ; in which state, being no longer aeriform, they must have parted, at least with a great part of their caloric : consequently, by electrization the oxygen attracts azote so powerfully as to not only part with its own caloric, but also to dislodge it from its union with azote.

He likewise allows that when this compound of oxygen with azote, this nitrous acid is electrified, the oxygen will acquire caloric and form oxygen gas : consequently by electrization oxygen acquires so strong an attraction to caloric that it will part with azote to combine with it, and form oxygen gas. This evident conclusion, so palpably contradicts the former, that either the experiments must be false, or the theory which pretends to explain them : but, we know that the experi-

ments are fair and conclusive ; consequently, the theory is lame, and by no means equal to their explanation.

These two experiments seemingly so contradictory to each other, are not so in reality, and may be most easily explained ; the inconsistency arising from Mr. Lavoisier's principles, and not from the facts themselves : but, were I to offer an explanation of them in this place, it would be premature, and could not be so well understood as when I come to speak of those gases, after explaining my ideas of the nature and composition of aeriform fluids in general, and of those gases in particular.

These, though not all the objections I have against theories of philosophy, ancient or modern, are the chief of those more immediately connected with my present subject. I shall therefore suspend the enquiry into what or how others think, and pursue the steps which appear most proper to explain my own ideas and theory of the principles



of chemistry and the nature and formation of aeri-  
form fluids ; and those who think differently are  
perfectly at liberty to give their reasons for think-  
ing otherwise, or not, just as they please.

## SECTION II.

*A summary View of the Elementary Principles of  
Bodies.*

FROM what hath been advanced in the preceding section, it appears perfectly consistent with reason and our knowledge of nature, to say, that every thing is material ; and, consequently, nothing can act, per se, at a distance from itself ; therefore, all the operations of nature are effected by *particles of matter in contact* with each other.

Particles of matter seem to differ widely amongst themselves ; some being obvious to our senses, forming bodies more or less solid and compact, and possessing, evidently, a specific gravity. These give us our ideas of fixed solid matter, and these particles, forming the basis, bulk and soli-

dity of every body, evident to our senses, and possessed of specific gravity, I for the sake of distinction call *fixed particles* of matter. A needle, formed of iron, or steel, by its compactness, weight and evidence to our senses, is an instance of a body composed of these *fixed* particles of matter.

The other kind of matter we are never sensible of but when it is peculiarly excited by being, or having been in contact, with those fixed particles of matter ; and then its general state is that of a subtile fluid, possessing no sensible degree of specific gravity, howsoever accumulated. In those cases, when evident, by its producing the phenomena of attraction or repulsion, it is surrounding the fixed particles of matter, or bodies composed of them, in an *atmospheric* state, light, subtile, yielding, elastic and permeable ; yet possessed of the power of evidently resisting the approach of a similar atmosphere ; consequently, its particles must be in a rectilinear state of arrangement, extending from the solid particle, which it surrounds as a centre, like radii, in all directions, naturally ; which lines of particles, not being contiguous,



but diverging as they recede from the centre, accounts for their subtilty and permeability.

An instance of this kind of matter, where particles are thus arranged, is the subtile magnetic atmosphere, furrounding the pole of a needle composed of fixed particles of matter ; and that the particles of this kind of matter, may be distinguished from the particles of fixed matter, I call them *active* or *actuated* particles of matter.

As these active particles of matter, when evident to us by their attractive, or repulsive operations, are always in some state of combination, or connexion with fixed matter, when they are always arranged in an atmospheric state around it, it is reasonable to suppose that the fixed particles of matter, by coming in contact with these active particles, excite them to arrange themselves around it, in the same manner as when a number of steel filings are touched by a magnet, they being immediately excited to attract each other, and arrange themselves in a radial manner ; the

magnet being the exciting cause, and the centre of that arrangement.

The existence of these *active* particles being incontestible, it is equally evident that they are of *two* kinds ; similar in their being excited by contact with fixed matter, to form themselves into atmospheres around it, but, yet, being *specifically different* ; as is evident from the magnetic atmospheres surrounding the poles of a needle ; each pole hath its magnetic atmosphere ; each atmosphere is attractive to iron ; the atmosphere surrounding the north pole of one magnet, will *attract* that surrounding the south pole of another ; but the atmosphere arranged round the north pole of one magnet, strongly *resists* the approach of a *similar* atmosphere, surrounding the north pole of another ; and the same repulsion exists between the atmospheres surrounding the south poles of two magnets : consequently, the atmosphere accompanying the north pole of a needle, is specifically different from that surrounding the south pole ; because so soon as they come in contact they *attract* each other, and draw their respective



poles together ; but two *similar* atmospheres have no attraction, but *resist* or *repel* each other.

These *active* particles, therefore, being of two kinds, I call one of them *phlogiston*, and the other *æther*, for the sake of distinction and perspicuity.

Besides this atmospheric state of existence, in which they draw the distant particles of fixed matter around which they are arranged, together, when one active principle surrounds one fixed particle, or mass, and the other active principle the other fixed particle, distant from it ; or in which they prevent two distant particles of fixed matter from coming together, when each fixed particle hath an atmosphere of the same kind of active particles ; these two active fluids, *æther* and *phlogiston*, are capable of being *excited* by fixed matter, and then of *combining* with each other, so as to form a *subtile compound*, capable of *existing* in a state of *separation* from the fixed particles of matter, by which they were actuated. In this state, according to the degree of excitement they



possessed at the moment of combination and liberation, they form fluids, possessed of different specific properties, which, however, are extremely subtile, active and without any specific gravity, such are light and fire : one, or other, or both of which being always produced, whenever æther and phlogiston, by attracting each other and drawing their respective fixed centres together, are left at liberty to separate from their respective fixed centres, by those centres attracting each other, and losing their power, in consequence, of detaining the æther or phlogiston with which they were combined : as for instance, when æther and phlogiston are excited by means of resin and glass, to form themselves into electric atmospheres around them, respectively, they attract, if within the reach of each other, and so soon as their respective fixed centres, the resin and glass, approach near each other, the electric atmospheres of æther and phlogiston, unite and pass away in the state of light, or fire.

The entire universe, therefore, is formed of particles of *matter*, in themselves exactly similar

throughout, being solid, or impenetrable points, monads, or atoms ; and all the different forms, changes and varieties of nature, are produced, by the *different properties* given to these simple material particles.

Those *properties* are of *two* general kinds. One portion of these original material particles, have, simply, the property of *attracting* the *other* particles of matter, in *all* points and directions, and *these* I distinguish by the name of *fixed particles* of *matter*. The *other* particles of matter, have the property of being *excited* by *contact* with the fixed particles of matter, to *attract* other particles *similar* to themselves, in *one direction only*, so as to form themselves into *right lines*, composed of particles, *singly arranged*, in *contact* : consequently, as the fixed particles attract these in *all* points and directions, these will *arrange* themselves around the fixed matter, as their *centre*, and form an *atmosphere* of radii, spherically surrounding the fixed centre ; which radial lines of particles, diverge as they recede from the centre. These I have called *active* particles of matter.



These active particles are of *two* kinds ; when *either* kind is *excited* by contact with fixed matter, it *attracts* particles of the *same* kind into *atmospheric* arrangement ; and *two* atmospheres of the *same* kind, surrounding two fixed centres, have *no* attraction for each other, but *resist* every attempt to bring them into the same place : but if an atmosphere of *one* kind be brought in contact with an atmosphere of the *other* kind, they will *attract* each other, so as to draw their respective fixed centres into contact. To one kind of these active particles I give the name of *æther*, and the other I distinguish by that of *phlogiston*.

The fixed particles are drawn together by these active particles, so as to form bodies more or less solid and bulky, according to the proportion of each, which enters into their composition : while the active particles themselves, by contact with those fixed particles, arrange themselves in an atmospheric, rectilinear form around them ; in which state they produce all the appearances of attraction, and repulsion, and all the various mu-



tations and operations of nature, which present themselves to the philosophic mind ; or, by combining together, in the states of light and fire, they give beauty, life and activity to the whole.

With these data I shall therefore proceed, and upon them shall found my future investigations.

## SECTION III.

*Particles of fixed matter, by being combined with one or other of the active kinds of matter, form fixed principles, of great activity, the alkaline and the acid principles.*

THE universality of the two active kinds of matter, which may, with great propriety, be called the two active principles, æther and phlogiston, and their powerful attraction to the fixed particles of matter, can leave no room to doubt that *every fixed* particle is combined with, and actuated by *one or other* of those *active* principles; for, in their original state, they must have been exposed to one or other of them, and, in consequence of that exposure, they would be immediately attracted, and form a combination, never more to be disunited; nothing being more pow-

erfully attractive to either the fixed or active particles, than, in that original state, they were to each other: consequently, whatever kind of active matter any fixed particle was originally exposed to, with that kind it is, and must be, forever united, to a certain extent: and that *indissoluble combination* forms a *fixed principle*, partaking of the fixity of the fixed particle, and of the activity of the active matter with which it is formed, and possessing *peculiar properties*, depending upon the *kind of active matter* with which the fixed particles are combined.

Though all fixed particles, therefore, are similar, yet those which are actuated by *æther*, acquire properties *different* from those combined with *phlogiston*; and as all of them must be united to either phlogiston or *æther*, the whole of the fixed particles must form *two compound, or fixed principles*: those combined with *æther* forming *one*, and those with *phlogiston* the *other fixed principle*.

But, as *æther* and phlogiston have different *specific properties*, 'tis evident, that the fixed



particles, actuated by *one*, must possess *specific* properties *different* from those combined with the *other* : and these two compound, or fixed principles, are the earthy or *alkaline* and the *acid principles* of chemists ; each possessing its peculiar properties, according to the nature of the active principle which enters into its composition ; and each having a strong attraction to the other, on account of the *natural attraction* which subsists between æther and phlogiston, in similar states of excitement.

In my Elementary Principles of Nature, I have entered more fully into the consideration of this subject, than is necessary in my present undertaking ; and have offered my reasons for supposing that the *alkaline principle*, is composed of a particle of *fixed matter*, actuated by an atmosphere of *æther*, to a certain extent ; and that the *acid principle* is formed of *fixed matter* united to *phlogiston*. If this supposition be admitted, that natural attraction between æther and phlogiston, will readily account for the attraction of the *alkaline principle* to phlogiston ; because its activity and

powers, as a principle, depend upon the æther combined with its fixed particle to a certain extent ; and, likewise, for the attraction of the *acid* principle to *æther*, on account of its specific properties, depending, upon its fixed particle, being actuated, so as to become a fixed principle, by its combination with *phlogiston*.

And that the supposition is true, appears from many considerations ; to instance one, the basis of a metal is evidently an earth ; and the firmness, solidity, or attractive force, by which its particles are compacted together, evidently depends upon phlogiston ; for, deprive it of that, and it loses its compactness and metallic properties, and becomes a loose incoherent mass. Now, if its compactness is lost, by taking away its phlogiston, it is just to suppose, that that phlogiston was the attractive power which kept its component particles of earth together ; and, consequently, that the active principle, upon which the active powers of the earthy principle depends, is attracted by the interposing phlogiston, and therefore is *ætherial* : for, if the properties of the earthy principle, as a principle

depended upon phlogiston, it is natural to suppose that the particles of metallic earth, would be more powerfully attracted to aggregation, in proportion as their atmospheres of phlogiston were *diminished*; because the more expanded those atmospheres are, the more powerfully they must resist approximation; and the more they are diminished, the greater must be their excitement, and power of aggregative attraction.

But I forbear to enter further into the subject here, because it is not my immediate object: it being sufficient for my present purpose, to observe, that the *earthy* or *alkaline principle* is *attractive* to, and capable of *combining* with *phlogiston*; and, that the *acid principle* is as powerfully *attractive* to *æther*; that in their *simple* states, they *attract*, *combine* with and *neutralize* each other; and, that, when the alkaline principle is united to phlogiston, and the acid principle to æther, in proper circumstances, the æther and phlogiston will unite together, and separate from their respective bases, which, by those means are brought together and combine with each other.



But as *each* of these *fixed principles* is capable of attracting an atmosphere, either of phlogiston or of æther, according to its nature, it must naturally follow, as these fixed principles are the *actuating centres*, which excite their respective active fluids to become atmospheres around them, that the atmospheric particles *nearest* the centre, must be *most excited*: as for example, the pole of a needle in a magnetic state, is surrounded by æther, or phlogiston in an atmospheric state; that pole gives excitement to those active particles, in consequence of which they attract each other in right lines, diverging from each other as they recede from the exciting centre; and their excitement, or attractive force *diminishes*, as *that distance* from the centre *increases*: so it must be with phlogiston and æther also, when excited to form atmospheres around the alkaline or acid principles, by being attracted by them; and, as the attractive power of the magnetic atmosphere, when very considerably distant from its exciting pole, is scarcely perceptible, so, also, the peculiar properties and degree of activity of phlogiston, or æther, when

widely distant from their respective centres of the fixed principles, are scarcely evident.

The *distinguishing property* of *phlogiston*, when it is excited to form an *atmosphere* around particles of the earthy principle, is *alkalinity*; consequently, when that phlogistic atmosphere is of *small* extent, its activity is *great*, and its *alkaline* property is *very evident*; as for instance in volatile alkali; but, if that atmosphere becomes *more* extensive, by the acquisition of more phlogiston, its alkaline property, or its activity must be *less*, as when volatile alkali is changed into alkaline air; and, if the quantity of phlogistic atmosphere be still *increased*, its alkalinity will *wholly disappear*; as is evident when that alkaline air is converted into inflammable air.

That peculiar kind of activity which is communicated to æther, when excited by being attracted to surround the acid principle, we call *acidity*: the *less* the quantity of æther, thus excited around the acid principle, the *greater* its activity, or, in other words, the *more* evident its acidity; as for

instance, when in the state of nitrous acid : but, if those ætherial atmospheres be *more* extended, by the further addition of æther, their activity, or acidity will be *less* ; or if *widely* extended, their acidity will be *no longer sensible*, as is the case when nitrous acid is converted into pure air.

*Alkalinity*, therefore, is no other than the *peculiar* state of *excitement*, which is given to *phlogiston*, when in an *atmospheric* state around particles of the *earthy principle* ; and, when *æther* is *excited*, by being attracted by the *acid principle*, its *peculiar*, state of *activity* we call *acidity* : and, if, when in the states of an alkali and an acid, these two principles be brought together, the *peculiar* activity of *each* active principle, will *counteract* that of the *other*, and give place to *mutual attraction*, which will terminate in *combination* and *neutrality*.



## SECTION IV.

*Chemical affinities are the evident attractions taking place between the two active principles; when one, or both are in a state of combination with the fixed principles.*

AS fixed particles of matter are never met with unless in a state of combination with one, or other of the active principles, and as all the activity, or evident properties of matter are produced by these active principles alone, or in combination with the fixed particles of matter, it is evident that *chemical affinities* are no other, than the combinations which take place between these *active principles*; which are subject to change, as their circumstances change from an imperfect connexion, to a more favourable opportunity of

combination, according to the respective degree of excitement which each active principle is possessed of: for, if phlogiston is in a state of great excitement, it will attract æther in a degree of moderate excitement, rather than nothing; but, if another body be added whose æther is more excited, that æther is more capable of attracting and satisfying that phlogiston, than the weakly excited æther already combined with it; in consequence of which it will dislodge the former, and, taking its place, will more completely saturate the phlogiston of the earthy body.

For example, fixed alkali is accompanied with phlogiston in a very active state; the acetous acid is combined with æther in a moderate state of excitement, which will, however, combine with the alkali, and, in a considerable quantity will neutralize it; but if vitriolic acid be added, whose æther is in a greater state of excitement, as is evident from its greater acidity, this æther, will, by its greater activity, dislodge the acetous acid, and, taking its place, will neutralize the alkali, and form a very close union with it, on account of the

similarly great degree of excitement, of the phlogiston of the one, and the æther of the other.

But as, on account of the strong attraction between the two fixed, the two active, and the fixed and active principles, few substances are to be met with which do not contain the four, in some proportion or other; and as their decompositions and consequent new combinations, must depend upon the state of activity, and proportionate quantity of each principle, forming the substances mixed together, it would be preposterous to attempt, with our contracted powers and imperfect knowledge, to give a full explanation of them; therefore I shall dismiss the subject here, with these observations, that chemical affinities are no other than one active principle attracting the other; and that decomposition is effected when one active principle, imperfectly connected, meets with the other active principle in more favourable circumstances, or in a state of excitement more nearly resembling its own; the circumstances of the other principles, not preventing the separation and new combination in consequence.



It may, perhaps, not be improper, however, to observe that though bodies composed of similar principles, have no chemical affinity to each other, yet, they can form an imperfect kind of union with each other, in certain circumstances ; for instance, two different acids will mix together, on account of the water with which they are combined, to which *each* hath an affinity ; and for the same reason two kinds of alkali will mix with each other in a state of solution.

## SECTION V.

*The degree of solidity, or compactness of bodies, depends upon the proportion, or state of the active matter combined with their fixed principles.*

THE degrees of solidity of bodies are numerous, but they may be reduced to three general states, solids, liquids and aeriform fluids ; to these might be added a fourth, that of extremely subtile fluids, such are light, fire and the magnetic and electric fluids ; but as these are only composed of the two active principles, without any admixture of fixed matter, they do not properly class with the former, or belong to this section.

The force by which the particles of solid bodies are held together, is called the *attraction of cohe-*

*sion* ; which, like every other attraction between different particles of matter, is effected by the action of the two active principles, accompanying the fixed particles, upon each other.

The *compactness* of bodies, does not altogether depend upon the quantity of fixed matter entering into their composition, for wood is more compact than mercury, though it does not contain nearly so much fixed matter as mercury does.

Particles of the *earthy* principle have no attraction to æther, but they have to phlogiston, and to the acid principle ; consequently, they may be attracted together into a solid form by the intervention of particles of the acid principle, or by phlogiston ; but if the quantity of phlogiston be considerable, they will be less forcibly attracted together, so as to admit of motion amongst themselves from slight causes, which state we call *fluidity* ; and if the quantity of phlogiston be very considerable, so as to form complete atmospheres around each earthy particle, they will be in an *aeriform state*.



The acid principle, in like manner, will be either solid, fluid, or aeriform, according to the quantity of æther combined with it ; if that quantity be small, it will be so powerfully attracted and excited by the contiguous particles of the acid principle, as to firmly connect them together in a solid form ; but if greater, its connecting power will be proportionately less ; and if very great, it will so far prevent their mutual approximation, as to keep them in an aeriform state.

A body entirely composed of the earthy principle and phlogiston, may by that quantity of phlogiston be rendered fluid, the phlogiston being in *too great* a proportion, to be *sufficiently excited* to keep the particles of earth *firmly* together, so as to form a solid ; as for instance mercury : while another body, chiefly composed of the earthy principle, with a *still greater* proportion of phlogiston, may be in a solid state ; for example wood : the reason is that the *earthy* particles of the wood are *partly* attracted together by some particles of the *acid principle*, while the æther, accompanying those acid particles, at the same time attracts the

the redundant phlogiston, by which means the four principles become fixed ; the activity of the æther and phlogiston being exerted upon each other, produce an attraction by which the whole are firmly held together.

Every solid body, therefore, owes its compactness either to the two fixed principles attracting each other : to the particles of either of the fixed principles, with a small proportion of the active particles to which it hath an affinity, in quantity just sufficient to be strongly excited by, and strongly attract the neighbouring fixed particles between which it is interposed, into combination : or to the two fixed and two active principles in certain proportions, strongly, mutually and closely attracting each other.

Fixed particles of matter in a state of fluidity, or in the rarer form of air, are always rendered so, by being connected with a large proportion of one, or other of the *active fluids*, æther and phlogiston ; or if the fluid, contains both the fixed principles, the two active fluids, being in differ-

ent states of excitement, may conspire to keep them asunder, so as to give them their fluid form—or they may be rendered fluid by the interposition of water, or fire; or even aeriform, if the quantity of fire, separating the active fluids in the composition by entering into arrangement with them, be sufficiently great.



## SECTION VI.

*The specific gravity of bodies, depends upon the quantity of fixed matter they respectively contain.*

IN whatsoever manner the fixed particles of matter are connected with, and surrounded by the active particles of matter, they still are accessible to either of the active principles ; because, as those active particles, by contaction with fixed particles of matter, become excited to arrange themselves in right lines, not contiguous, 'tis evident that in that radial or atmospheric state, there must be *numberless intermediate spaces*, through which *other active particles* can pass, in every direction, without resistance, even so far, as the central particle of fixed matter itself ; and, as the active particles of matter *always* become more

or less excited, by coming in contact with fixed matter, 'tis evident, that were either *æther* or *phlogiston*, in a disengaged state, to come in contact with any substance, containing fixed matter, they would become *excited* around that substance ; and on this property the *attraction* of *gravitation* depends.

Phlogiston and *æther* are universally present, and universally extended ; they penetrate to the centre of the earth, and to the centre of every particle of the fixed principles composing it ; and not only the earth, they pervade also the sun, and to the very centre of *every solid* in the universe : by thus pervading all matter, they, from *that matter*, receive an *excitement*, in consequence of which they become *attractive* to each other ; the lines of *ætherial* particles, excited by one body, and extending towards others, *attract* the *phlogistic* lines of particles excited by, and extended from those other bodies, and vice versa.

'Tis evident, therefore, that the larger the mass of matter, the greater must be the number

of lines of active particles, thus excited to surround it ; and, consequently, the greater its power of attraction, by which lesser bodies will be drawn to it, if no other power prevents ; and *this kind of attraction is called gravitation.*

The *specific gravity* therefore, of any body, is proportionate to the *quantity* of *fixed particles* of matter it contains ; because they alone are capable of giving, or being acted upon by this state of excitement of the active fluids producing the attraction of gravitation.

Particles of fixed matter, being already surrounded by these active principles in other states of excitement, are not prevented from being subject to this attraction of gravitation, no more than a needle is hindered by a magnetic atmosphere from acquiring an atmosphere of the electric fluid ; for the active fluids, in *this state* producing gravitation, have no action upon *those* surrounding active particles of matter in different states of excitement, no more than the electric fluid hath upon the same principles in a magnetic state ;



they only penetrate the void spaces of the atmospheres formed by the former, till they come in contact with the fixed centres; by which they become excited, and form lines of particles, extending from one body to another, whose only property is that of *drawing* the two bodies together.

The specific gravity, therefore, of any body, cannot be either increased or diminished by any quantity of fire, light, æther, or phlogiston, either added to, or taken from it; because they are active principles, or composed of active principles; and in their states of combination with fixed matter, or with each other, their excitement is *so different* from that producing the attraction of gravitation, that they have no sensible attraction to æther or phlogiston in that state of slight excitement, producing the attraction of gravity, which is given to the disengaged and universally diffused æther and phlogiston by fixed particles of matter alone: consequently, as they, in that state, have no action upon æther or phlogiston when in different states of excitement, by

chemical union with fixed matter, the specific gravity of any body cannot be affected by the quantity of æther or phlogiston united to that body, but by the number of fixed particles of matter alone, which enters into its composition ; for *they alone* can give to æther and phlogiston, that state of excitement producing the attraction of gravity, and consequently, *they only* can be affected by them in that state.

## SECTION VII.

*On Fire and Light.*

**B**EFORE I enter upon the subject of aeriform fluids, it will not be improper to say something concerning fire and light ; since they are so intimately connected with the subject, and so essentially necessary in the operations, by which aeriform fluids are produced.

I have said that fire is formed when æther and phlogiston, attracting each other, are left at liberty to separate from their respective fixed principles ; which happens when those fixed principles, by being brought together by them, so perfectly satisfy each other, that they have no longer any attraction to their respective active principles.



For example, the candle, now burning before me, consists chiefly of phlogiston united to the alkaline or earthy principle ; as all combustible bodies do, in some proportion or other.

Pure air, which consists of the acid principle rendered aeriform by æther, forms a considerable part of the atmospheric air in the room. Fire having been applied to the candle, that fire, by its power of entering into arrangement with the phlogistic atmospheres of the earthy particles of the candle, so far extended those phlogistic atmospheres, as to weaken their affinity with the earthy principle ; in consequence of which, that phlogiston became capable of acting upon the ætherial atmospheres of the pure air, and the acid, central particles of the pure air, were drawn into contact with the earthy particles of the candle, and combined with them to saturation ; the æther and phlogiston thus united were set at liberty and flew off in the state of fire with light. This fire, by its general attraction to all active matter, partly enters into the remaining part of the candle, promotes the expansion of its phlogiston, and

keeps up the combustion; while part is attracted by the two fixed principles, from which it was separated, in their new state of combination, and elevates them into vapour. When that vapour meets with other substances, containing a less proportion of fire than itself, part of that fire leaves those particles, which, being only expanded into the state of vapour by means of that fire, by its being taken from them, they become condensed into a fluid state, and form water, if the acid and earthy particles were in such a state, as to perfectly neutralize each other: but, if the earthy principle exceeded in quantity, or had not a sufficient proportion of phlogiston; or the combustion was not sufficiently violent, to enable the two fixed principles to combine perfectly, then, the imperfect combustion, or the excess of earthy matter will form a precipitate, or residuum under the form of soot.

So again when pure air, composed of the acid principle and æther, is mixed with a sufficient quantity of inflammable air, consisting of the alkaline principle and phlogiston, and exploded to-

gether, the ætherial and phlogistic atmospheres of the two airs, attract each other, draw their respective fixed principles into contact, and become at liberty to combine and pass away in the state of flame ; the two fixed principles combining with each other, and forming water ; being perfectly neutral, if the two airs were perfect in their qualities and proportions and the combustion properly conducted. *Fire*, therefore, is no other than *æther* and *phlogiston*, when they combine forcibly together, and are set at liberty, by their respective fixed centres saturating each other, and therefore no longer *detaining* them in their atmospheric state of arrangement.

This fire, then, diffuses itself, into all the bodies, around, by its general attraction to the æther or phlogiston they naturally contain ; it therefore, in a measure, incorporates itself with those atmospheres, increases their extent, and, consequently, weakens their union with their respective fixed particles, and renders all bodies, more or less, liable to decomposition, in proportion to the quantity in which it is present.



But as the powers, properties and activity of fire, depend upon the *freedom* and *excitement* of its æther and phlogiston when they combine, when it is attracted by the active atmospheres of other bodies into arrangement with them, so as to expand them, by that attraction and detention, it loses a great part of its activity, and can no longer render itself evident to us, on account of its fixity ; but so soon as the circumstances of that body, thus expanded by the fire taken into arrangement with its component active principles, are altered, so that its proper active fluids can again come into contact, and contract themselves to their proper mode of arrangement, the particles of fire, being pushed aside and no longer attracted, recover their former activity, and shew their usual effects as fire, sensibly at liberty.

Fire, therefore, being a compound of æther and phlogiston, and capable of weakening the chemical affinities of bodies by attracting, combining with, and expanding the active principles in their composition, it must oftentimes happen that the

fixed principles of those bodies, when separated by its interposition, if they be in states of considerable activity, will decompose the fire itself; each fixed principle attracting that active principle of the fire to which it hath an affinity,

For instance, mercury is composed of the earthy principle and phlogiston: pure air of the acid principle and æther.

The phlogiston of the mercury, is so closely combined with the earthy principle, that the æther of the pure air in its expanded state, hath no sensible action upon it, in the common temperature of the atmosphere; but, if the mercury be heated, the fire, mixing itself with the phlogiston in its composition expands it, till it is less powerfully attracted by the earthy principle, when, it becomes attractive to the æther of the pure air. The effect of this attraction, is, to draw the fixed centres of the respective active principles into contact; the acid principle of the pure air is, therefore, drawn to the earthy principle of the mercury, when, they attract each other,

combine and form a calx ; in which state each fixed principle loses its attraction, to the active principle formerly attending it ; and the æther and phlogiston, combining, form fire, or light, and, being at liberty, pass away. But, if this calx of mercury, composed of the earthy and acid principles attracting and satisfying each other, be put into a close vessel, and strongly heated, the quantity of fire, insinuating itself between the earthy and acid principles, will destroy their union, and prevent them from being in contact, or nearly so ; in consequence of which, they can no longer attract and satisfy each other ; therefore, the attractive power of *each*, will be exerted upon the *active principle* with which it hath an affinity, of which the *fire* itself is composed : the earth of the mercury will attract *phlogiston*, and recover its metallic lustre and properties ; and the acid principle will attract the æther, which was combined with that phlogiston ; by which æther its particles will become aeriform, and expand into the state of pure air.

The *earth* of mercury, therefore, if its phlo-



gifton is as it were loosened from it, by the interposition of a moderate quantity of fire, and that phlogiston be attracted by the æther of pure air, will *combine* with the *acid* principle and form a calx ; leaving the phlogiston and æther to pass away in the state of fire : but, if this calx be exposed to so great a degree of heat, as to entirely separate the acid principle from the earth, each fixed principle, being in a state of great activity, and no longer capable of existing in the state of combination with the other, they must necessarily return to their pristine state, by decomposing the fire, which, by its interposition dissolves their union with each other. For this degree of heat does not destroy the attraction of the earthy principle to phlogiston, or of the acid principle to æther, but it entirely prevents the earthy principle from attracting the acid principle, by disuniting them ; therefore, as their attraction to each other is destroyed, the attraction of each is necessarily exerted upon the active principle with which it hath an affinity.

In all probability this decomposition of fire, is

effected in ten thousand operations of nature.—

Without the presence of a certain quantity of fire vegetation is at a stand ; light itself without fire is insufficient ; but vegetation may go on without light ; though it seems necessary to give beauty and perfection to the vegetable creation. Light itself is no other than the same two principles, æther and phlogiston, only in a different state, from what they are in when they form fire. We know that light, when it falls upon an opaque body is actually changed into fire, because the quantity of fire, produced by means of light, is always in proportion to the quantity of light thrown upon the opaque body ; and that fire, thus produced, is evidently the light itself which is converted into fire, because neither the air, nor any alteration in the principles, or composition of the opaque body, are necessary to its production ; as is sufficiently evident from throwing light, collected into a focus, upon a piece of black marble, for instance, in vacuo :—the great quantity of light, thrown upon it, is lost, as light, and an intense heat, or great quantity of fire is formed, without the presence of air, or any change being

made in the principles of the marble, more than their being expanded by the fire produced.

When the sun, therefore, becomes more vertical and his rays more direct, at the approach of spring, they are also more numerous, and the face of nature is more enlightened. This light, falling upon the earth and the vegetable kingdom, by the opacity of the soil, of the stems and branches of plants, &c. and afterwards of their springing leaves, is changed into fire ; which increasing in quantity with the increasing light, and commixing itself with the *active principles* contained in vegetables, expands them till they no longer attract their *fixed* principles into a torpid *solid*, or a *sluggish lentor*. The juices become fluid, and the more solid parts acquire an increase of activity from the fire combined with them ; the fixed principles, thus rendered more distant, attract each other together, less forcibly ; and, consequently, their powers of attraction, which were exerted upon, and satisfied with each other, before, now seek for something else to act upon ; they, therefore, actually seize upon whatever is



present in a state capable of being decomposed by them ; in consequence of which action, certain kinds of air, light, and even fire itself are liable to be decomposed by them ; and the necessary and proper principles are taken into their composition, so as to support their growth and be converted, by the process of vegetation, into that endless variety of forms and qualities, which the vegetable kingdom presents to our senses.

By means of fire, therefore, vegetables and even minerals may be rendered capable of decomposing water, light, and even fire itself, and of taking certain parts, or principles from them, into their own composition.

In short, the whole of what is necessary to be said, in this place, on *fire*, is, that whenever an atmosphere of *æther* united to the acid principle, is in a similar state of excitement with an atmosphere of *phlogiston*, surrounding its centre of the alkaline principle, they attract each other ; the consequence of that attraction, is that their respec-

tive fixed centres are brought towards each other ; and if nothing be present to prevent those two fixed principles from entering into strict union, they will form a neutral compound, and having no longer any strong attraction to their respective atmospheres, the *æther* and *phlogiston* combine, and form fire ; in which state they diffuse themselves around.

This fire readily pervades all bodies : it not only insinuates itself between the lines of active particles, arranged to a greater or less extent around all fixed particles of matter, but it hath also the power, by its general attraction to *æther* and *phlogiston*, of insinuating itself among their particles in their arrangement ; in consequence of which, their atmospheric extent is increased, and the body which they partly form is expanded in all directions, in proportion to the quantity of fire taken into that arrangement ; but, in this case, the fire is but slightly detained, and readily quits that body, to enter into any contiguous one containing a less quantity of it,



If the quantity of fire be so great as to expand the component atmospheres, connecting fixed particles together, so much as to destroy their peculiar state of combination, and put them into a very different one, as for example, changing a solid into a fluid, or a fluid into vapour ; the component atmospheres, by being thus expanded, lose much of their attractive force upon each other, and exert it upon the interposing *fire*, which is, therefore, more strictly detained by them, and its *activity* or *sensible* action is less evident ; but still it is *undecomposed*, and will gradually make its escape into colder bodies, if near it, till the component atmospheres of the substance can again attract each other, so forcibly as to recover their former more compact state ; when, at the very moment of this re-arrangement, the remaining part of the fire, which kept them expanded, is in a great measure pushed out of that arrangement, and becomes sensibly active ; as is abundantly evident in many operations, when bodies suddenly change from a rarer, to a more solid form.



If a substance composed of the two fixed principles, in a state of great activity, attracting and saturating each other, be exposed to the action of a great quantity of fire, a quantity so great as to *remove* those *two fixed* principles, *from* each other, by its *interposition*; they, being no longer capable of touching, attracting, and satisfying each other, will, *singly*, exert their whole attractive force upon the *fire* itself; the *acid* principle attracting its *æther*, and the *earthy* principle its *phlogiston*; by which means a portion of the fire is entirely *decomposed*; and being no longer fire, now that its principles are disunited, each active principle gives *new properties*, to the *fixed principle* by which it is attracted and detained.

With respect to light, I, in this place, have little more to say, than that it is evidently composed of *æther* and *phlogiston*; and its essential properties seem to depend upon its *velocity*; for if it be impeded in its progress by an opaque body, the force with which it meets the resisting body, is sufficient to *alter* the *mode of combination* of its

*æther* and *phlogiston*, which immediately *change* into *fire*.

It appears, however, to me highly probable, that light is no other than the *æther* and *phlogiston*, *universally* expanded through creation, *thrown* into *undulations*, by means of any ignited body, or in fact by fire, or by means of *æther* and *phlogiston* in other states of activity, capable of putting them in motion : that their rarity, and the *velocity* with which their *undulations* are made, afford sufficient data to explain the *reflections* and *refractions* of light, and likewise their being changed into the state of *fire*, when they meet with *resistance* sufficient to *arrest* their motion, and destroy their *properties*, as *light* ; and this conjecture appears to me much more reasonable, than to suppose, that *every* body, giving *light*, is rendered luminous by the light contained *within itself*, or formed by the *decomposition* of its own *principles*. But this subject, at present, I shall no further insist upon.

But, whether light be a part of the luminous body by which it is rendered evident, or whether it be the æther and phlogiston every where present, put in motion by an ignited body, it is still *æther and phlogiston*, in a *certain state of activity*, and is capable of being *decomposed*, and its æther and phlogiston may separately be taken into composition with the fixed principles of bodies, in certain states of excitement, in the same manner as fire is ; and, in many cases, it seems to be more readily decomposed than fire itself ; for instance, the acid principle, in the state of nitrous acid, will attract *æther* from light, and form itself, by the acquisition of that æther, into pure air, more readily, than it will from fire alone ; while the phlogiston, separated from that æther, by light being decomposed, is attracted by the earthy principle, separated from that acid, which, by the acquisition of that phlogiston, becomes more coloured, and diffuses itself in the subnatant acid.

Having thus briefly mentioned the properties of fire and light, more strictly chemical, it will



not be improper to take a general view of *water*, and its leading principles and properties, as being also generally concerned in chemistry and aeriform fluids.

## SECTION VIII.

*On Water.*

**W**ATER is now so clearly proved to be a compound, that few will contradict the assertion, and none will ever be able to bring proofs to the contrary.

The late grand and accurate experiment, made at paris, by Mess<sup>rs</sup>. Fourcroy, Vauquelin and Seguin, in which 1039 grains of hydrogenous and 6210 of oxygenous gases, amounting to 7249 grains, being slowly decomposed, produced 7245 grains of pure water, a small residuum of compound gas remaining, is so decisive, that no doubt can remain of water being formed of the bases of those two airs, attracting, or saturating each other; and as it is equally well known, that an

alkali may be converted by fire and the electric fluid into Inflammable air, and that an acid may, by the same means, be converted into pure air, and as the expanded atmospheres of each kind of air, during their combustion with each other, disappear, in the forms of fire, or light, it is very evident, that *water* is formed by the *acid* and *alkaline principles*, to a certain degree *deprived* of their active atmospheres, attracting and neutralizing each other.

This neutral compound of the two fixed, or the acid and alkaline principles, seems, however, to take place before the fixed principles are very far deprived of their respective active atmospheres, because, when deprived of fire, so far as to be no longer fluid, at the moment of congelation the natural tendency to arrangement of the active fluids, is evident in the regular manner in which the particles of water arrange themselves, when they become *ice*: 'tis likewise evident in the strong affinity betwixt this compound and fire, which is readily taken into arrangement with the remaining part of the active atmospheres, by



which they lose their power of consolidation, and become fluid, or *water*; which atmospheres may be so widely extended by their attraction to fire, if present in a sufficient quantity, as to expand into the state of vapour, in which state, however, the water is not decomposed, but, only so far expanded, by the interposition of fire, that one compound, or aqueous particle of the acid and alkaline principle, no longer attracts any other aqueous particle; the attraction between the acid and alkaline principle still remaining, though but slightly combined and very liable to decomposition.

Water, being a compound of the two fixed principles, hath a general attraction to most bodies, whether composed of *either* of the *fixed principles*, or *both* of them; particularly *those*, whose fixed particles are in a state of considerable *activity*, such as acids, alkalis and salts; in consequence of which general attraction, it weakens their attraction for each other, and insinuates itself among them, so as to render them in a state of solution, when present in a sufficient quantity;

in which state, the body dissolved, or diluted by it, is not decomposed, or altered in its specific properties, but by its component parts being thus divided, and their attraction to each other diminished, they are more subject to decomposition, than when free from the interference of water.

This *general attraction* of water to the *fixed principles* of bodies ; is something similar to the *general attraction* of fire to the *active principles* of bodies ; and the effect of each, respectively, is, by *interposition* to weaken the mutual attraction, existing between the component particles of bodies, by which they become expanded, and more readily decomposed, in certain circumstances.

It was observed in the section on fire, that when the two fixed principles, in considerable states of activity, or having active atmospheres of very small extent, are forcibly separated from each other by any means, as by fire, or the electric fluid, so as to be no longer within the reach of each other, that they then will exert their activity upon the active principle to which each hath

an affinity, and which they find present in the fire or electric fluid by which they become separated, so, that being no longer capable of existing as a neutral compound, each fixed principle satisfying the other, they will *each* attract an atmosphere of active particles, and become aeriform; consequently, water, being a compound of the two fixed principles, is liable to decomposition.

If the electric fluid be transmitted through water, properly confined, as in the Haerlem experiment, the electric shock, by its violent effect, separates the two fixed principles, so, that they can no longer attract each other; the alkaline particles therefore attract phlogiston from the passing electric fluid, and, at the same time, the acid particles attract æther, and each becomes aeriform; the alkaline particles, with their phlogistic atmospheres, being in the state of inflammable, and the acid particles of pure air; when the two airs thus mixed together are formed in quantity sufficient to displace part of the water, so that the electric fluid must pass through a portion of the gases, the next electric shock, accends the æthe-



rial and phlogistic atmospheres, which, rushing into flame, draw the two fixed principles together, as their respective atmospheres burn away, till they are left united, and neutralizing each other, in their original state of water.

Water, indeed, is readily decomposed in numberless circumstances; particularly when expanded by fire, and exposed to the action of substances, whose principles are considerably disunited and rendered active, by the same means. If, then, *one* of the *fixed principles* of water be attracted by the heated substance, and that substance can supply the *active principle* naturally attracted by the *other fixed principle* of the water, the water will be readily decomposed; *one* of its *fixed principles* combining with the *substance* employed, and the *other*, becoming *aeriform* by means of the *active fluid* dislodged from that heated body. As for instance, iron is composed of the alkaline or earthy principle and phlogiston; water of the alkaline and acid principles, by means of fire the two principles forming each substance are violently separated, in consequence of which, the earthy base of

the iron attracting the *acid principle* of the *water*, have a tendency to combine; and by that attraction taking place, the earth of the iron less forcibly attracts its *phlogiston*, which, is therefore attracted by the nearly disengaged *alkaline principle* of the *water*, and a real change of principles then takes place. The *acid particles* of the *water* combine with the earthy base of the iron, and form a calx; and, at the same time, the *phlogiston* disengaged from the iron is attracted by the disengaged *alkaline particles* of the *water*, and surrounds them in an atmospheric state, so as to form *inflammable air*.

*Water*, therefore, is formed whenever the *two fixed*, the *acid* and *alkaline principles* are deprived of their *active atmospheres*, to a certain degree; chiefly by combustion, and combine together in a certain proportion, so as to form a *perfectly neutral residuum*, or *compound*: it is generally attractive to the *fixed principles* of most bodies, and is capable of being *decomposed* by certain other substances, particularly when *one* of its fixed principles is attracted, and the *other*, at the same time, is suppli-

*ed* with the *active principle* to which it hath a natural attraction, so as to enable it to take the form of *air*.

Having thus taken a general view of the principles of chemistry, and its chief agents, I shall proceed to the general theory of aeriform fluids, the particular object of this essay.



## SECTION IX.

*The general Theory of Aeriform Fluids, or Gases.*

FROM what hath been advanced in the preceding pages, it appears evident, that a *simple particle* of *air* is formed of a *particle* of *one* of the *fixed principles*, as the *basis*, or *centre*, surrounded by a number of *particles* of *one* of the *active principles*.

The principle of *acidity*, one of the *fixed principles*, naturally attracts that *active principle*, which I call *æther* ; and the *alkaline*, or *other fixed principle*, hath a strong affinity with the *other active principle*, or *phlogiston*.

If a *particle* of either of the *fixed principles*, be, by any means, put into an *active state*, the

other fixed principle not being present to combine, or capable of uniting with it, if that active principle, with which it hath a natural affinity, be present, it will immediately exert its attractive power upon those active particles, by which they will become *excited* to attract each other into arrangement. But, the nature of this *excitement* of the *active particles*, is such, that they attract each other only in *one point*, or *direction*, so as to form a *line* of *particles*, *singly arranged*, in *contact* with each other, immediately extending from the fixed particle by which they are excited. Every particle of active matter, therefore, which is in *contact* with the *surface* of the *fixed* particle, becomes capable of attracting and exciting *other similar particles* into a *rectilinear arrangement*; and, therefore, the fixed particle, as the centre, will be surrounded by so many *lines* of active particles, singly arranged in contact, as there are *active particles* in *contact* with it; these lines of active particles extending from the centre, in all directions, to a certain distance, gradually *diverge* from each other, as their distance from the centre increases; and, as the fixed particle of matter is the centre

of excitement, their activity and force of arrangement must *diminish*, as their distance from that central source of excitement, *increases*; being greatest near the centre, and least at the circumference or greatest extent.

Aeriform fluids are light; their specific gravity is very small when compared with that of water, for instance; consequently, the number of fixed particles of matter they contain, in any certain quantity, by measurement, is much less than is contained in an equal bulk of water; the specific gravity entirely depending upon the proportion of the *fixed principle* or *principles* in any given substance, as was particularly explained in the section on the specific gravities of bodies.

The power of resistance in these active atmospheres, when fully extended, is small; because the particles, being arranged *one by one*, the resistance made by any single particle, can only equal the *force* by which it is *attracted* by the *particle* in *contact* with it, nearer to the centre; consequently, having *no lateral support*, the resistance made by



any *single line* of *active particles*, must be *small* ; and, if, by yielding to the force of *pressure*, they come in contact with the neighbouring lines, their *united force* of *counteraction*, especially when considerably expanded from their centre, will still be *inconsiderable*.

But, as these active particles have a *certain force*, or *power* by which they naturally *arrange* themselves in a *rectilinear* manner, 'tis evident, if the *pressure* made upon them, *ab extra*, by which they were forced out of their natural direction, be taken away, or the particle of air hath freedom of motion in every, or any other direction, but that of the resisting body, that, in the former case, the *distorted lines* will *instantly return* to their *natural rectilinear form* ; and, in the latter, the particle of air will be *pushed aside* by the *force* of *arrangement*, maintaining itself against the *pressure* endeavouring to destroy it. Upon this force or power, by which the active particles naturally attract each other in a *rectilinear* manner, the *elasticity* of *aeriform fluids* depends.

It may, therefore, be compressed, by any force, *greater* than the *sum* of the *forces* of *arrangement*, of the particles, or lines of particles acted upon; and, when that pressure is taken away, the atmospheres will *again expand*, with a *force*, proportionate to the *degree* of *distortion*, and the number of *lines suffering* that distortion; the elastic force of *expansion* gradually *diminishing*, as they approach *nearer* to their *natural direction*.

Air is likewise capable of great expansion by means of fire.—For, when speaking of fire, it was observed, that it hath a general attraction to the two active principles, when in an atmospheric state, around particles of fixed matter, by which, it not only insinuates itself into the interstices between the atmospheric lines of particles, but, it also is capable, when present in considerable quantity, by means of its general attraction, of intruding itself into *arrangement* with them; by which, those atmospheres must consequently be *expanded* to a *greater extent* from their respective centres, and *those centres* must, therefore, become *more distant* from *each other*.

In this case, however, the fire is only *interposed*, not *decomposed*; and, though it weakens the attraction between the fixed centre and its active atmosphere, and makes them more ready to be decomposed, or entirely separated, yet, if a body, containing a less proportion of fire, be brought into contact, the fire escapes from its arrangement, passes into the colder body, and leaves the active particles to return to their former state of arrangement; when, they occupy no more space than they did before their expansion.

The air in the lower parts of the atmosphere, near the surface of the earth, must be greatly compressed, by the weight of the air above it; consequently, the *atmospheric arrangement* around the fixed centre of every particle of air, in these lower parts, must be *greatly distorted*, and those lines *closely pressed together*: when, therefore, the receiver of an air-pump is *partly* exhausted, part of this pressure being taken away, those atmospheric lines around each remaining fixed centre, will gradually recover their rectilinear state, and expand, so as to still fill the receiver; and if the



exhaustion be carried further, till *each atmosphere* acquires its full extent, they will gradually attract the *fire* from the receiver, and that from surrounding bodies, to *take into* their *arrangement*, and *increase* their *extent* ; as is evidently proved by the sinking of the mercury in the thermometer, as the exhaustion proceeds.

## SECTION X.

*Simple aeriform fluids are of two kinds.*

AS all aeriform fluids are formed either of the alkaline, or the acid principle, or both, surrounded by atmospheres of phlogiston, or æther, or both, according to their respective affinities, it is evident, that the *simple gases*, containing no more than *one* of the *fixed principles* as their base, can only be of *two kinds* : *one kind* have bases of the *alkaline*, and the *other* of the *acid principle* ; consequently, as the *alkaline principle* is only attractive to the *phlogistic* active fluid, and the *acid principle* to *æther*, *all simple aeriform fluids* are either composed of the *alkaline principle* with *phlogiston*, or of particles of the *acid principle* with *atmospheres* of *æther*.

There being then only *two kinds* of *simple gases*, phlogistic and ætherial, it must follow, likewise, that there are only *two perfect simple airs*, or *gases*; *one* formed by the pure alkaline principle with its *full atmosphere* of phlogiston, and the *other* composed of the acid principle, in its simplest state, with a *complete atmosphere* of æther.

Either the *alkaline*, or *acid principle*, in certain states of activity, when exposed to the action of æther and phlogiston, or bodies composed with them, in certain circumstances, will attract the active principle with which it hath an affinity, and become *aeriform*.

Either of the fixed principles, simply rendered aeriform by means of its proper active principle, but not in the *full quantity* and *extent* which it is capable of, forms an aeriform fluid, but *less perfect* than the former; for the imperfect atmosphere, being of *less extent*, is *more active* than when the atmosphere is of its *full extent*; the *activity* of every atmosphere *diminishing*, in propor-



tion as it becomes *more distant* from the exciting fixed centre.

The *most perfect* aeriform state, therefore, of the *alkaline principle*, is that, which is produced by simply exposing it to the action of æther and phlogiston, either in the state of fire, or of the electric fluid; when, by their interposition, it is *separated* from any connexion with the acid principle, it decomposes them, and seizes their *phlogiston*; when, therefore, by these means, it hath acquired its *greatest extent* of atmosphere, its alkaline properties are no longer evident, as is the case when volatile alkali, by means of fire and the electric fluid, is converted into *inflammable air*; which is, therefore, the *most perfect* state of the *alkaline principle*, rendered *aeriform* by means of *phlogiston*.

The *acid principle* will, likewise, acquire its *most perfect* aeriform state, by the same means; the acid principle attracting the *æther* of the fire, or electric fluid; when it hath, therefore, acquired its *full extent* of *ætherial* atmosphere, it shews

no signs of acidity, and is in its *most perfect* state ; as is the case with pure nitrous acid, which, by means of the *æther* it acquires, by exposure to the action of fire, or the electric fluid, becomes *perfectly aeriform*, and is in fact *pure air*.

*Inflammable air*, is, therefore the most perfect of the *phlogistic* aeriform fluids with bases of *alkali*, and *pure air* of the *ætherial fluids* with bases of the *acid principle*. If these two be mixed together, in a proper proportion, they will have little sensible action upon each other, because each atmosphere is so fully and widely extended around its respective basis, as to be scarcely excited and nearly inactive ; but, if they be still more extended by fire, they will then actually *separate* from their former *arrangement*, and, acquiring activity by ignition, will *themselves combine* and form *fire*, and, communicating their activity to the rest, the *whole* of the *phlogistic* and *ætherial* atmospheres will rush *together* ; their respective bases, by that means, will be brought into *contact* and form a *neutral compound*,—*water* ;—and, the *phlogistic* and *ætherial* atmospheres, thus violently acquiring

their *liberty*, will *combine* and escape in the form of *flame*, in which is fire and light.

If an alkali be thrown into the state of air by means of phlogiston, but where that phlogistic atmosphere is of *less extent*, and, consequently, *imperfect*, that phlogiston will be *sensibly active*, as being more excited by being less distant from the exciting fixed centre; as is the case when volatile alkali is changed, by heat, into *alkaline air*: which, however, seems not to be *entirely* composed of the pure alkaline principle, and phlogiston.

So, likewise, when an acid acquires, by the same means, æther enough to render it aeriform, but not so much as to change it to pure air, it is possessed of *evident chemical activity* and forms an acid air; though not *wholly* formed of the acid principle with æther.

If this alkaline and acid air be mixed together, the phlogiston of the one, and the æther of the other, being each in similar states of activity, will



instantly attract each other and draw their respective fixed centres together ; the alkaline and acid centres, thus brought into contact, will unite and form a neutral salt ; while the phlogistic and ætherial atmospheres, being in great part disengaged, will combine, and, producing heat, will gradually escape, as the combination of the two gases proceeds.

But, if inflammable air be mixed with vitriolic acid air for instance, or pure air with alkaline air, the atmospheres of *one* being *full, perfect* and *extended* till the power of excitement from the fixed centre *ceases*, while those of the *other* are *imperfect*, of *smaller extent* and *considerably active*, though one atmosphere is phlogistic and the other ætherial they will *not* attract each other,—they cannot combine, while *each* continues in *that* state of excitement, so *different* from *that* of the *other* ; because, in considerably different states of excitement, æther and phlogiston cannot combine ; for, to enable them to unite, their action upon each other must be *mutual* and *equal*. Therefore, it is evident, that when one is much excited and

the other but little, the *strong* attraction of *arrangement* amongst the *particles much excited*, will exceed the *weak* attraction of *combination* exerted by the *contrary particles* but *little excited*; therefore, the weaker attraction, from the contrary principle, will not be able to overcome the stronger attraction of arrangement, by which the active particles, composing the more excited atmosphere, are held together; consequently, the two gases, tho' one is phlogistic and the other ætherial, will remain mixed together, tho' undecomposed and, singly, unaltered.

No two aerial atmospheres of æther and phlogiston, therefore, can attract each other and combine, unless the *external* particles of the *one*, are in a similar state of *excitement* and *activity*, or nearly so, with the *most distant* particles, forming the *extremity* of each atmospheric line of the *other*; or, unless by fire, or other violent means, they be put into *that state* of *equal excitement*; because it is the *last*, or *most distant* particle of *each* atmospheric line, alone, that is capable of *acting* upon *any other* particle; and attraction and combination

must *first begin* with *them*, and proceed, by communication, to the next particles in arrangement, till the fixed centres are brought together : because, were a particle of phlogiston to be applied to the 2<sup>nd</sup> *particle* from the extremity of any atmospheric line of ætherial particles, *that* 2<sup>nd</sup> *particle* could have *no attraction* to it—all *its* excitement and activity being exerted upon the *particle* before and that *beyond* it, which, by that excitement and power are held in *arrangement* ; and, consequently, it hath no power of attraction but what is already employed. But, if an extreme, or most distant particle of phlogiston, is *equally excited* with an *extreme*, or terminating *particle* of æther, they will combine, and draw the 2<sup>nd</sup>, or next *particle* of æther, into contact with the 2<sup>nd</sup>, or succeeding particle of phlogiston, which two succeeding particles will, *then*, become *attractive* to *each other* ; because the two extreme particles by attracting each other, no longer attract and are attracted by those succeeding particles nearer the fixed centre, as they were before, when they were excited by the attraction of arrangement alone ; for, by the attraction of arrangement, *each* active particle is



attracted by *that* in contact with it, nearer the fixed centre, and by that attraction becomes *excited* to attract that *exciting particle* in return ; and, at an *opposite point* becomes capable of *attracting another particle*, with a force nearly equal to that by which it is attracted ; so, that particles of æther, or phlogiston, when excited by fixed matter to arrangement, are similar to the filings of iron when actuated by a magnet ; in their common state they are without order, but, when the magnet is applied, the particle next the magnet is excited ; it then attracts and is attracted by *one* extremity of the next filing ; which, by that means, becomes excited at its *other* extremity to attract the next succeeding particle of iron, and so on, progressively, till the arrangement of the filings is complete ; each attracting and being attracted by the *particle* of iron, immediately *preceding* and *succeeding* it ; the *last*, or *extreme* particle, however, being *only* attracted and attracting at *one* of its poles, the other pole being equally excited, is ready to *exert* its *power* upon any thing, with which it hath an affinity ; if, in a state of excitement similar to its own,

Were, therefore, æther and phlogiston, in *similar* states of *excitement*, at *equal distances* from their respective fixed centres, it is evident, that an atmospheric line composed of 100 particles of æther, would attract an atmospheric line of phlogiston containing 100 particles, their excitement being equal ; but, if the atmospheric line of phlogiston was composed with 120 particles, the *last*, or the 120<sup>th</sup> *particle* of phlogiston, from the centre, would *not* be so *much excited* as the 100<sup>th</sup> particle of æther ; and its force of attraction of *combination* with that ætherial particle, would not *equal* the force of the attraction of *arrangement* by which that 100<sup>th</sup> particle of æther, is attracted, by its contiguous, or 99<sup>th</sup> particle of æther ; the two atmospheres, therefore, would have *no sensible action* upon each other.

And, were we to suppose that the last particle of æther, being at the distance of 100 from its centre, would attract the 100<sup>th</sup> particle of phlogiston from its centre ; and that, if that extreme ætherial particle was applied to the 100<sup>th</sup> particle of phlogiston, being the 20<sup>th</sup> from the extremity

of the line of which it forms a part, a little recollection would soon inform us of the error ; because, *that* particle of phlogiston being in *arrangement*, *each* of its active poles are occupied, and *all* its *powers of attraction* are *already exerted* upon the particles of phlogiston already in *contact* with it ; consequently, it could not form any combination with the ætherial particles, unless the particles of phlogiston were removed from its pole most distant from the fixed centre, while the other pole still remained attracted in arrangement, and both its poles consequently excited.

There are, therefore, but *two general* kinds of *air* :—aeriform fluids with atmospheres of *phlogiston*, surrounding particles of the *alkaline principle* ; and with atmospheres of *æther* accompanying particles of the *acid principle* :—and there are but *two* aeriform fluids, *perfect* and *simple*, which are *inflammable air*, where the alkaline principle is surrounded by phlogiston, to its *utmost extent* of *attraction* ; and *pure air*, which is formed of the acid principle, surrounded by as much æther as it is capable of *giving proper excitement* to.



But, there are many other aeriform fluids; some chiefly composed of the alkaline principle with phlogiston; others of the acid principle and æther;—some with atmospheres considerably excited and active, and others with atmospheres not sensibly active;—but these, being chiefly composed of *all* the *four* principles, in some proportion or other, open a field, too wide to be entered into at this time; my present intention being only to take a *general view* of the subject, and not to enter into particulars.

FINIS.

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